Grant Number N00014-91-J-1764
Final Technical Report
1992-1995

Personnel

Faculty

Zafra Lerman	Head, Institute for Science Education and Communication (Columbia College)
Nestor A. Schmajuk	Associate Professor (Duke University) and Adjunct Professor (Columbia College)
Geof Goldbogen	Chairman, Academic Computing (Columbia College)

Students

Hugh T. Blair	Graduate Student (Northwestern University)
David Morton	Undergraduate Student (Columbia College)
Silvano Zanutto	Post-doctoral Student (Duke University)

BOOKS

1. Schmajuk, N.A. Animal learning and cognition: A neural network approach. Cambridge University Press. In press

PUBLICATIONS

1. Schmajuk, N.A. and DiCarlo, J.J. Stimulus configuration, classical conditioning, and the hippocampus. Psychological Review, 99: 268-305, 1992.

2. Schmajuk, N.A., and Thieme, A.D. Purposive behavior and cognitive mapping: An adaptive neural network. Biological Cybernetics, 67, 165-174, 1992.

3. Quinn, K.J., Schmajuk, N.A., Baker, J.F., and Peterson, B.W. Simulation of adaptive mechanisms in the vestibulo-ocular reflex. Biological Cybernetics, 67, 103-112, 1992.

4. Quinn, K.J., Schmajuk, N.A., Jain, A., Baker, J.F., and Peterson, B.W. Vestibuloocular reflex arc analysis using an experimentally constrained neural network. Biological Cybernetics, 67, 113-122, 1992.

5. Christiansen, B.A., and Schmajuk, N.A. Hippocampectomy disrupts the topography of the rat eyeblink conditioned response during acquisition and extinction of classical conditioning. Brain Research, 595, 206-214, 1992.

6. Schmajuk, N.A. Connectionist approaches to the mind. Contemporary Psychology, 38, 146-147, 1993.

7. Schmajuk, N.A., and Blair, H.T. Dynamics of spatial navigation: An adaptive neural network. In From Animals to Animats 2, J-A. Meyer, H.L. Roitblat, and S.W. Wilson (Eds.), pp. 243-252, Cambridge, MA: MIT Press, 1993.

8. Schmajuk, N.A., and Blair, H.T. Place learning and the dynamics of spatial navigation: An adaptive

neural network. Adaptive Behavior, 1, 355-387, 1993.

9. Schmajuk, N.A., Thieme, A.D., and Blair, H.T. Maps, routes, and the hippocampus: A neural network approach. Hippocampus, 3, 387-400, 1993.

10. Schmajuk, N.A., and Christiansen, B.A. Eyeblink conditioning in the restrained rat: A novel preparation. Kopf Carrier, March, 1993.

11. Perry, B., Luchins, D., and Schmajuk, N.A. Altered Dopamine receptor binding site densities in rat brain following hippocampal lesions. Pharmacology, Biochemistry, and Behavior, in press.

12. Schmajuk, N.A., Lam, P., and Christiansen, B.A. Hippocampectomy disrupts latent inhibition of the rat eyeblink conditioning. Physiology and Behavior, 55, 597-601, 1994.

13. Schmajuk, N.A. and Blair, H.T. Stimulus configuration, place learning, and the hippocampus. Behavioral Brain Research, 59:103-117, 1993.

14. Schmajuk, N.A., and Blair, H.T. Time, space, and the hippocampus. In N.E. Spear, L.P. Spear, and M.Woodruff (Eds.), Neurobehavioral plasticity: Learning, development, and response to brain insult. Hillsdale, NJ: Erlbaum Associates, in press.

15. Schmajuk, N.A., Urry, D., and Zanutto, B.S. The frightening complexity of avoidance: An adaptive neural network. In J.E.R. Staddon and Clive Wynne (Eds.), Models of action. Hillsdale, NJ: Erlbaum Associates, in press.

16. Schmajuk, N.A. Conditioning and Neural Networks. In M. Arbib (Ed.), The Handbook of brain theory and neural networks, Cambridge, MA: MIT Press, in press.

17. Schmajuk, N.A. Cognitive Maps. In M. Arbib (Ed.), The Handbook of brain theory and neural networks, Cambridge, MA: MIT Press, in press.

18. Schmajuk, N.A. Behavioral dynamics of escape and avoidance: A neural network approach. In From Animals to Animats 3, D. Cliff, P. Husbands, J-A Meyer, & S.W. Wilson (Eds.), pp. 118-127, Cambridge, MA: MIT Press, 1993.

19. Schmajuk, N.A. Review of Intelligent Behavior in Animals and Robots by D. McFarland and T. Bosser. The Quarterly review of Biology, 69, 429, 1994.

PAPERS SUBMITTED

20. Schmajuk, N.A., Lam, Y.W., and Gray, J.A. Latent inhibition: A neural network approach. Behavioral and Brain Sciences

21. Schmajuk, N.A., and Axelrad, E. Communication and consciousness: A neural network conjecture. Behavioural and Brain Sciences.

22. Christiansen, B.A., and Schmajuk, N.A. Haloperidol reinstates latent inhibition impaired by

hippocampal lesions. Behavioral Neuroscience

23. Schmajuk, N.A., Lamoureux, J., and Holland, P. Occasion setting and stimulus configuration: A neural network approach. Psychological Review

COMMUNICATIONS TO SCIENTIFIC MEETINGS

1. Schmajuk, N.A., & Thieme, A. A neural network approach to cognitive mapping. Thirty-second Annual Meeting, The Psychonomic Society, San Francisco, California, November 22-24, 1991.

2. Schmajuk, N.A., & Thieme, A. Role of the hippocampus in cognitive mapping. Third Midwestern Hippocampal Meeting, Northwestern University, Evanston, IL, July 27, 1991.

3. Goldbogen , G. , Lerman, Z.M., Morton, D. and Pienkos, F. Visual communication and its impact on spatial learning. I. Third Annual Argonne Symposium for Undergraduates in Science, Engineering, and Mathematics, Argonne National Laboratory, November 6, 1992.

4. Schmajuk, N.A. Backpropagation, classical conditioning, and hippocampal function. XXV International Congress of Psychology. Brussels, 19-24 July, 1992.

5. Schmajuk, N.A., & Thieme, A. Cognitive mapping: A neural network approach. Sixty-fourth Annual Meeting of the Midwestern Psychological Association, Chicago, IL, April 30-May 2, 1992.

6. Schmajuk, N.A. Backpropagation and hippocampal function. Meeting of the British Experimental Psychology Society, York, United Kingdom, July 1992.

7. Schmajuk, N.A., & Urry, D.W. Escape and avoidance revisited: A neural network approach. Thirty-third Annual Meeting, The Psychonomic Society, St. Louis, Missouri, November 13-15, 1992.

8. Christiansen, B.A., and Schmajuk, N.A. Hippocampal lesions disrupt latent inhibition. Twenty Second Annual Meeting, Society for Neuroscience, Anaheim, California, October 25-30, 1992.

9. Schmajuk, N.A., and H.T. Blair. The dynamics of spatial navigation: An adaptive neural network. Simulation of Adaptive Behavior: From animals to animats. Honolulu, Hawaii, December 7-11, 1992.

10. Goldbogen , G. , Lerman, Z.M., Morton, D. and Pienkos, F. Visual communication and its impact on spatial learning. II. Fourth Annual Argonne Symposium for Undergraduates in Science, Engineering, and Mathematics, Argonne National Laboratory, November 5, 1993.

11. Schmajuk, N.A. Backpropagation, context, and hippocampal function. 14th Annual Winter Conference on the Neurobiology of Learning and Memory, Park City, Utah, January 9-12, 1993.

12. Schmajuk, N.A., & Urry, D.W. A neural network approach to avoidance. Sixty-fifth Annual Meeting of the Midwestern Psychological Association, Chicago, IL, April 30-May 1, 1993.

13. Perry, B., Luchins, D., and Schmajuk, N.A. Hippocampal lesions and dopamine receptor density. Anual Meeting of the American Psychiatric Association, San Francisco, May 1993.

14. Schmajuk, N.A., & Urry, D.W. Prediction and reinforcement in avoidance: A neural network approach. Meeting of the Society for the Quantitative Analysis of Behavior, Chicago, IL, May 26-27, 1993.

15. Schmajuk, N.A. Modeling the effect of aspiration and ibotenic acid lesions of the hippocampus. Fifth Midwestern Hippocampal Meeting, Northwestern University, Evanston, IL, June 4, 1993.

16. Schmajuk, N.A., & Gray, J.A. Latent inhibition: A neural network approach. Thirty-fourth Annual Meeting, The Psychonomic Society, Washington, D.C., November 5-7, 1993.

17. Christiansen, B.A., and Schmajuk, N.A. Latent inhibition: Effects of haloperidol and hippocampal lesions. Twenty Third Annual Meeting, Society for Neuroscience, Washington, D.C., November 7-12, 1993.

18. Goldbogen , G. , Lerman, Z.M., Morton, D. and Pienkos, F. Visual communication and its impact on spatial learning. III. Fifth Annual Argonne Symposium for Undergraduates in Science, Engineering, and Mathematics, Argonne National Laboratory, November 5, 1994.

19. Schmajuk, N.A. Stimulus configuration, classical conditioning, and spatial learning: Role of the hippocampus. Invited talk at the World Congress on Neural Networks. San Diego, June 4-9, 1994.

20. Schmajuk, N.A. Behavioral dynamics of escape and avoidance: a neural network approach. Simulation of Adaptive Behavior: From animals to animats. Brighton, England, August 8-12, 1994.

21. Schmajuk, N.A., Lamoureux, J., and Holland, P. Occasion setting and stimulus configuration: A neural network approach. Thirty-fifth Annual Meeting, The Psychonomic Society, St. Louis, Missouri, November 11-13, 1994.

22. Schmajuk, N.A, & Axelrad, E. Animal communication: A neural network approach. Meeting of the Eastern Psychological Society, Boston, MA, April 1995.

COMPUTER SOFTWARE

1. Blair, H.T., Lam, Y.W., & Schmajuk, N.A. (1992). Pascal version of the model described in Schmajuk, N.A. and DiCarlo, J.J. Stimulus configuration, classical conditioning, and the hippocampus. Psychological Review, 99: 268-305, 1992.

2. Blair, H.T., & Schmajuk, N.A. (1993) Pascal version of the model for classical conditioning described in Schmajuk, N.A. and Blair, H.T. Stimulus configuration, place learning, and the hippocampus. Behavioral Brain Research, 1993.

3. Blair, H.T., & Schmajuk, N.A. (1993) Pascal version of the model for place learning described in Schmajuk, N.A. and Blair, H.T. Stimulus configuration, place learning, and the hippocampus. Behavioral Brain Research, 1993.

4. Lam, Y.W., & Schmajuk, N.A. (1993). Pascal version of the model described in Schmajuk, N.A., Lam, Y.W., and Gray, J.A. Latent inhibition: A neural network approach. Behavioral and Brain Sciences, under revision

BOOKS

Schmajuk, N.A. ANIMAL LEARNING AND COGNITION: A NEURAL NETWORK APPROACH Cambridge University Press, in press.

This book describes several connectionist theories of animal learning and cognition. Starting at the simple assumption that psychological associations are represented by the strength of neural synaptic connections, mechanistic descriptions of complex cognitive behaviors are provided. Part I describes neural network theories of classical conditioning and discusses the concepts of models of the environment, prediction of future events, reliable and salient predictors, redundancy reduction, competition for limited capacity short-term memory, mismatch between predicted and observed events, stimulus configuration, inference generation, modulation of attention by novelty, storage and retrieval processes, and timing. Part II describes neural networks of operant conditioning, specifically avoidance, introduces the concept of response-selection mechanisms, and applies operant conditioning principles to the description of animal communication. Part III describes goal-directed mechanisms, spatial mapping, and cognitive mapping. Finally, Part IV shows how neural network models permit to simultaneously develop psychological theories and models of the brain.

ABSTRACTS OF SOME PUBLICATIONS SUPPORTED BY ONR

1. Schmajuk, N.A. and DiCarlo, J.J. Stimulus configuration, classical conditioning, and the hippocampus. Psychological Review, 99: 268-305, 1992.

This study describes hippocampal participation in classical conditioning in terms of a multilayer network that portrays stimulus configuration. The network (a) describes behavior in real time, (b) incorporates a layer of "hidden" units positioned between input and output units, (c) includes inputs that are connected to the output directly as well as indirectly through the hidden-unit layer, and (d) employs a biologically plausible backpropagation procedure to train the hidden-unit layer. The model correctly describes the effect of hippocampal and cortical lesions in the following paradigms: (1) acquisition of delay and trace conditioning, (2) extinction, (3) acquisition-extinction series of delay conditioning, (4) blocking, (5) overshadowing, (6) discrimination acquisition, (7) discrimination reversal, (8) feature-positive discrimination, (9) conditioned inhibition, (10) negative patterning, (11) positive patterning, and (12) generalization. Some of these results might be extended to the description of anterograde amnesia in human patients.

2. Schmajuk, N.A., and Thieme, A.D. Purposive behavior and cognitive mapping: An adaptive neural network. Biological Cybernetics, 67, 165-174, 1992.

This study presents a real-time, biologically plausible neural network approach to purposive behavior and cognitive mapping. The system is composed of (a) an action system, consisting of a goal-seeking neural mechanism controlled by a motivational system; and (b) a cognitive system, involving a neural cognitive map. The goal-seeking mechanism displays exploratory behavior until either (a) the goal is found or (b) an adequate prediction of the goal is generated. The cognitive map built by the network is a topological map, i.e., it represents only the adjacency, but not distances or directions, between places. The network has recurrent and non-recurrent properties that allow the reading of the cognitive map without modifying it. Computer simulations show that the network successfully describes latent learning and detour behavior in rats. In addition, simulations demonstrate that the network can be applied to problem-solving paradigms such as the Tower of Hanoi puzzle.

3 Christiansen, B.A., and Schmajuk, N.A. Hippocampectomy disrupts the topography of the rat eyeblink conditioned response during acquisition and extinction of classical conditioning. <u>Brain Research</u>, 595, 206-214, 1992.

The effects of hippocampal lesions (HL) on acquisition and extinction of eyeblink *conditioning were analyzed. Although HL affected neither acquisition nor extinction rates, HL animals showed significantly shorter CR onset latency during acquisition and extinction, and larger CR peak amplitude during acquisition.

4. Schmajuk, N.A. Connectionist Approaches to the Mind Review of Michael C. Mozer's The perception of multiple objects: A connectionist approach. Cambridge, MA: MIT Press, 1991

In "The Perception of Multiple Objects", Michael Mozer offers a connectionist model capable of Multiple Object Recognition and Attentional Selection (MORSEL). In general, as prescribed by the connectionist approach, the book presents precise mathematical descriptions and quantitative computer simulations of the model's most important functions. Sometimes, however, the accounts are qualitative and simply justified in terms of single examples. The balance between both strategies is adequately maintained throughout the book. In the tradition of connectionist models, MORSEL provides valuable intuitions into the problem of visual perception, recognition, and attention. Because it offers a mechanistic description of psychological processes, it contributes a basis for the study of the neurophysiological foundations of word recognition. In addition, when quantitative descriptions are provided, they can be strictly compared with experimental data. In sum, the books offers an impressive contribution to the field.

5 Schmajuk, N.A., and Blair, H.T. Dynamics of spatial navigation: An adaptive neural network. In <u>From Animals to Animats 2</u>, J-A. Meyer, H.L. Roitblat, and S.W. Wilson (Eds.), pp. 243-252, 1993.

We present a real-time neural network capable of describing place learning and the dynamics of spatial navigation. The network generates spatial generalization surfaces that can guide navigation from any location that is within view of familiar landmark cues, even if that location has never been visited before.

6. Schmajuk, N.A., and Blair, H.T. Place learning and the dynamics of spatial navigation: An adaptive neural network. <u>Adaptive Behavior, 1</u>, 355-387, 1993.

We present a real-time neural network capable of describing place learning and the dynamics of spatial navigation. The network generates spatial generalization surfaces that can guide navigation from any location that is within view of familiar landmark cues, even if that location has never been visited before. Spatial navigation is accomplished by adopting a "stimulus-approach" principle, that is, by approaching appetitive places and avoiding aversive places. When generalization surfaces are assumed to represent forces driving animal's behavior, the dynamics of spatial movements can be described. Computer simulations were carried out for appetitive, aversive, and aversive-appetitive place learning. The paper shows that the network correctly describes the navigational trajectories and dynamics of many spatial learning tasks.

7. Schmajuk, N.A., Thieme, A.D., and Blair, H.T. Maps, routes, and the hippocampus: A neural network approach. <u>Hippocampus, 3</u>, 1993, 387-400.

This study describes hippocampal participation in maze navigation in terms of a real-time,**1.** biologically plausible neural network. The system incorporates a cognitive map system and a route system. The cognitive map is a topological map that stores associations between Places and Views of accessible Places, and between Places and reward. The route system establishes associations between Cues and reward. Both systems compete with each other to establish associations with the reward, with the

cognitive system generally overshadowing the route system.

In agreement with previous models (Schmajuk, 1989; Schmajuk and DiCarlo, 1992), it is assumed that the hippocampus modulates the storage of cognitive maps in cortical areas, and mediates the competition between cognitive maps and route systems. After hippocampal lesions, animals navigate through mazes making use of the route system. Computer simulations show that the network effectively describes latent learning, detour behavior, and place learning in normal, hippocampal and cortical lesioned animals.

8. Schmajuk, N.A., Lam, P., and Christiansen, B.A. Hippocampectomy disrupts latent inhibition of the rat eyeblink conditioning. Physiology and Behavior, 55, 597-601, 1994.

The effect of hippocampal aspiration lesions on latent inhibition of eyeblink conditioning in the restrained rat preparation was examined. Rats received either sham, cortical control, or hippocampal aspiration lesions. Control animals, but not animals with hippocampal lesions, showed slower conditioning after being preexposed to the conditioned stimulus (latent inhibition). Together with previous results regarding the effect of hippocampal lesions in acquisition and extinction of delay conditioning, the present study suggests that the restrained rat preparation may serve as a reliable way of investigating hippocampal participation in different classical conditioning paradigms.

9. Schmajuk, N.A. and Blair, H.T. Stimulus configuration, place learning, and the hippocampus. Behavioral Brain Research, 59, 103-117, 1993.

Schmajuk and DiCarlo (1992) introduced a neural network, which utilizes a biologically plausible It is important to notice that this extension does not modify the model's learning rules for the CR, but only the computation of the responses for the different systems.backpropagation procedure, to describe compound conditioning, feature-positive patterning, negative patterning, and positive patterning during classical conditioning. The model correctly describes many experimental results under the assumption that aspiration lesions of the hippocampus eliminate (a) the competition between simple and configural stimuli to gain association with the unconditioned stimulus and (b) stimulus configuration.

The present study extends the network to describe place learning. Under the assumption that ibotenic acid lesions of the hippocampus only impair stimulus configuration, the model correctly shows that ibotenic acid lesions might spare simultaneous negative and positive patterning but impair place learning. In general, the results are taken to support a hippocampal role in stimulus configuration.

10. Schmajuk, N.A., and Blair, H.T. Time, space, and the hippocampus. In N.E. Spear, L.P. Spear, and M.Woodruff (Eds.), Neurobehavioral plasticity: Learning, development, and response to brain insult. Hillsdale, NJ: Erlbaum Associates, in press.

Schmajuk and DiCarlo (1992) and Schmajuk and Blair (1993) presented a neural network model capable of generating predictions of future events in time and space. In the context of this model, accurate generation of predictions depends on the processes of configuration and competition. Configuration refers to the combination of simple stimuli into a complex stimulus, which represents a pattern of stimuli that better predicts the future than its individual constituents. Competition refers to the selection of the stimulus best predicting the future from among different simple and complex stimuli.

In the context of the network, the hippocampus is assumed to provide error signals that control the formation of configurations in cortical regions, and to compute the "aggregate prediction" signal that regulates competition in subcortical areas. According to the model, whereas aspiration lesions of the hippocampus eliminate both cortical configuration and subcortical competition, ibotenic acid lesions of the hippocampus abolish only cortical configuration. The model correctly describes the effects of hippocampal aspiration and ibotenic acid lesions on several temporal (classical conditioning) and spatial learning paradigms.

11. Schmajuk, N.A. Behavioral dynamics of escape and avoidance: A neural network approach. In From Animals to Animats 3, D. Cliff, P. Husbands, J-A Meyer, & S.W. Wilson (Eds.), pp. 118-127, Cambridge, MA: MIT Press, 1993.

12. Schmajuk, N.A., Zanutto, B.S., Urry, D. W. Avoidance revisited: a neural network approach. Adaptive Behavior, submitted.

We present a novel, real-time two-process theory of escape and avoidance that closely integrates classical and operant conditioning processes. In cognitive terms, the model assumes that through classical conditioning animals build an internal model of their environment and that through operant conditioning animals learn alternative behavioral strategies. The internal model provides predictions of what environmental events precede other environmental events, such as the US. Behavioral strategies refer to the responses generated in different environmental circumstances. Whenever there is a mismatch between predicted and actual environmental events (a) the internal model is modified and (b) the behavioral strategies are adjusted. Specifically, the classical conditioning process generates associations between the warning stimulus (WS), the unconditioned stimulus (US), and the responses (R) generated by the animal with the US. Whereas the WS and the US become predictors of the US, the escape response (Re) and the avoidance response (Ra) become predictors of the absence of the US. The operant conditioning process associates the WS and US with those responses that predict the absence (or the reduction) of the aversive US (Re and Ra). The classical conditioning process (a) provides predictions of the presence or absence of the US used by the operant conditioning process to generate WS-R and US-R associations, and (b) controls the strength of the responses. Because the WS and the US can become associated with different available responses, animals can learn distinct escape and avoidance responses. Since the model describes behavior in real time, it is able to capture the effects of using different temporal WS and US arrangements and to describe the latency of avoidance and escape responses. The model describes many of the features that characterize avoidance behavior in shuttle-box, running wheel, leg-flexion, and Sidman avoidance tasks.

13. Schmajuk, N.A., Lam, P., and J.A. Gray. Latent Inhibition: A neural network approach. Behavioral and Brain Sciences, under revision.

Latent inhibition is a phenomenon in which the association of a conditioned stimulus with an unconditioned stimulus is retarded by preexposing the conditioned stimulus alone. This study describes a novel theory of latent inhibition in the context of a real-time neural network. The network assumes that animals build an internal model of the world to generate predictions of environmental events (Sokolov, 1960). Whenever predicted and observed events differ, orienting responses are emitted, ongoing behaviors are inhibited, and attention to stimuli is increased, in proportion to the total novelty detected (Gray, 1971).

In the model, environmental stimuli activate internal representations. An attentional system enhances internal representations of events active at a time when the total environmental novelty is large (by increasing attention), and decreases internal representations of those events active at a time when the total novelty is small (by decreasing attention or increasing inattention). The magnitude of the internal representations control the storage of information into the model of the environment (associability) and the retrieval of information from the model (retrievability).

The amplitude of the conditioned response is proportional to the magnitude of the prediction of the unconditioned stimulus. The amplitude of the conditioned response is inhibited by the orienting response, which is assumed to be proportional to total novelty.

According to the model, latent inhibition reflects the decreased internal representation of a CS as a consequence of decreased attention or increased inattention after preexposure to that CS. Computer simulations show that the neural network correctly describes many features that characterize latent inhibition.

14. Schmajuk, N.A., Lamoureux, J., and Holland, P. Occasion setting and stimulus configuration: A neural network approach. Psychological Review, submitted.

Schmajuk and DiCarlo (SD) (1992) presented a neural network model of classical conditioning that succesfuly describes complex classical conditioning paradigms such as negative patterning, positive patterning, feature positive patterning, feature negative patterning, and compound conditioning. The present paper introduces an extension of the SD model that (a) simultanoeusly describes the output of multiple response systems in real time, (b) incorporates "hidden" units that represent configural stimuli and generalization between input stimuli, (c) includes inputs directly and indirectly connected to the output, and (d) employs a biologically plausible backpropagation procedure. The model characterizes occasion setting as the result of the interaction between simple CS-US and configural CS-US associations.

The model is able to describe most paradigms that distinguish simple conditioning from occasion setting: (1) response form during simultaneous and serial feature-positive discrimination, (2) feature-positive discrimination and extinction effects, (3) feature-negative discrimination and counterconditioning effects, (4) transfer effects during feature-positive and feature-negative discriminations, (5) within-category transfer, temporal factors such as (6) X-A and X-US intervals effects, (7) effects of X-A, X-US and A-US intervals, (8) termination asynchrony effects, (9) relation of within- and between-trial time intervals, nontemporal factors such as (10) target intensity, (11) feature-target similarity, and (12) pretraining of separate elements. In addition, the model correctly describes the effects of hippocampal aspiration and ibotenic acid lesions on occasion setting.

15. Schmajuk, N.A., and Axelrad, E. Communication and consciousness: A neural network conjecture. Behavioural and Brain Sciences, submitted

The communicative aspects of the contents of consciousness are analyzed in the framework of a neural network model of animal communication. We discuss some issues raised by Gray, such as the control of the contents of consciousness, the adaptive value of consciousness, conscious and unconscious behaviors, and the nature of a model's consciousness.

16. Goldbogen, G., Lerman, Z.M., Morton, D. , and Pienkos, F. Visual communication and its impact on spatial learning, submitted.

The effect of the quality of a visual representation on computers on improving learning of a computer-simulated maze has been studied. The maze was modelled and scripted on a Silicon Graphics Personal Iris using TDI (Thomson Digital Image) software to incorporate both color and texture. The test of the maze task was done on a Macintosh computer using Micromind Director software. Subjects were students of Columbia College that live in urban and suburban areas. It was found that subjects living in urban areas performed better in the maze task than subjects living in suburban areas.

OFFICE OF THE UNDER SECRETARY OF DEFENSE (ACQUISITION)
DEFENSE TECHNICAL INFORMATION CENTER
CAMERON STATION
ALEXANDRIA, VIRGINIA 22304-6145

IN REPLY REFER TO DTIC-OCC

SUBJECT: Distribution Statements on Technical Documents

TO: OFFICE OF NAVAL RESEARCH
CORPORATE PROGRAMS DIVISION
ONR 353
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

1995 1026 084

1. Reference: DoD Directive 5230.24, Distribution Statements on Technical Documents, 18 Mar 87.

2. The Defense Technical Information Center received the enclosed report (referenced below) which is not marked in accordance with the above reference.

FINAL REPORT
~~N00014-J-1764~~ N00014-91-J-1764
TITLE: INSTITUTE FOR SCIENCE AND COMMUNICATION (COLUMBIA COLLEGE)

3. We request the appropriate distribution statement be assigned and the report returned to DTIC within 5 working days.

4. Approved distribution statements are listed on the reverse of this letter. If you have any questions regarding these statements, call DTIC's Cataloging Branch, (703) 274-6837.

FOR THE ADMINISTRATOR:

GOPALAKRISHNAN NAIR
Chief, Cataloging Branch

1 Encl

FL-171
Jul 93

DISTRIBUTION STATEMENT A:

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

DISTRIBUTION STATEMENT B:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; (Indicate Reason and Date Below). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT C:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND THEIR CONTRACTORS; (Indicate Reason and Date Below). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT D:

DISTRIBUTION AUTHORIZED TO DOD AND U.S. DOD CONTRACTORS ONLY; (Indicate Reason and Date Below). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT E:

DISTRIBUTION AUTHORIZED TO DOD COMPONENTS ONLY; (Indicate Reason and Date Below). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT F:

FURTHER DISSEMINATION ONLY AS DIRECTED BY (Indicate Controlling DoD Office and Date Below) or HIGHER DOD AUTHORITY.

DISTRIBUTION STATEMENT X:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS OR ENTERPRISES ELIGIBLE TO OBTAIN EXPORT-CONTROLLED TECHNICAL DATA IN ACCORDANCE WITH DOD DIRECTIVE 5230.25, WITHHOLDING OF UNCLASSIFIED TECHNICAL DATA FROM PUBLIC DISCLOSURE, 6 Nov 1984 (Indicate date of determination). CONTROLLING DOD OFFICE IS (Indicate Controlling DoD Office).

The cited documents has been reviewed by competent authority and the following distribution statement is hereby authorized.

A

(Statement)

OFFICE OF NAVAL RESEARCH
CORPORATE PROGRAMS DIVISION
ONR 353
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

(Controlling DoD Office Name)

(Reason)

(Controlling DoD Office Address, City, State, Zip)

Debra T. Hughes

DEBRA T. HUGHES
DEPUTY DIRECTOR
CORPORATE PROGRAMS OFFICE

(Signature & Typed Name)

(Assigning Office)

19 SEP 1995

(Date Statement Assigned)